

# OPERATING INFORMATION

## SIGNAL GENERATOR

8654A

DUPLICATE OF SECTIONS 1 THRU 3  
OF YOUR OPERATING AND SERVICE MANUAL  
KEEP WITH INSTRUMENT

OCTOBER 1973

HEWLETT  PACKARD

## MODEL 8654A



POWER CABLE



FUSE



NOTE: See ACCESSORIES SUPPLIED in Section I for part number information.

Figure 1-1. HP Model 8654A and Accessories Supplied

## SECTION I GENERAL INFORMATION

### 1-1. INTRODUCTION

1-2. This manual contains information pertaining to installation, operation, testing, adjustment, and maintenance of the Model 8654A Signal Generator.

1-3. The information in this manual is divided into sections as shown below:

a. Section I, GENERAL INFORMATION, instrument identification, description, accessories, specifications and other basic information.

b. Section II, INSTALLATION, incoming inspection, power requirements, mounting, packing, and shipping of the instrument.

c. Section III, OPERATION, provides information relative to operating the instrument.

d. Section IV, PERFORMANCE TESTS, provides information required to ascertain that the instrument is performing in accordance with published specifications.

e. Section V, ADJUSTMENTS, provides information required to properly adjust and align the instrument after repairs are made.

f. Section VI, REPLACEABLE PARTS, provides ordering information for replaceable parts and assemblies.

g. Section VII, MANUAL CHANGES, contains backdating information for earlier equipment configurations.

h. Section VIII, SERVICE, includes information required to troubleshoot and repair the instrument.

1-4. Figure 1-1 shows the Hewlett-Packard Model 8654A Signal Generator with accessories supplied. Refer to ACCESSORIES SUPPLIED in Section I for HP Part Numbers.

1-5. Packaged with this manual is an Operating Information Supplement. This is simply a copy of

the first three sections of this manual. This supplement should stay with the instrument for use by the operator. Also included with the manual is an overall schematic diagram. Additional copies of both the Operating Information supplement and the Overall Schematic Diagram may be ordered separately through your nearest Hewlett-Packard office. The part numbers are listed on the title page of this manual.

1-6. On the title page of this manual, below the manual part number, is a "Microfiche" part number. This number may be used to order 4x6-inch microfilm transparencies of the manual. Each microfiche contains up to 60 photo duplicates of the manual pages. The microfiche package also includes the latest Manual Changes supplements as well as all pertinent Service Notes.

1-7. Instrument specifications are listed in Table 1-1. These specifications are the performance standards or limits against which the instrument may be tested.

### 1-8. INSTRUMENTS COVERED BY MANUAL

1-9. This instrument has a two-part serial number. The first four digits and the letter comprise the serial number prefix. The last five digits form the sequential suffix that is unique to each instrument.

1-10. An instrument manufactured after the printing of this manual may have a serial prefix that is not listed on the title page. This unlisted serial prefix indicates that the instrument is different from those documented in this manual. The manual for this instrument is supplied with a yellow Manual Changes supplement that contains change information that documents the differences.

1-11. In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is keyed to this manual's print date and part number, both of which appear on the title page. Complimentary copies of the supplement are available from Hewlett-Packard.

1-12. For information concerning a serial number prefix not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

### 1-13. DESCRIPTION

1-14. The 8654A is designed to develop a sinusoidal RF output signal from 10 to 520 MHz at power levels of +10 to -130 dBm into a 50-ohm load. Amplitude and/or frequency modulated outputs are obtainable; the modulating signal may be selected from an internal or external source.

### 1-15. ACCESSORIES SUPPLIED

1-16. The accessories supplied with the 8654A are:

a. A 1/8 amp fuse, HP 2110-0027, for use when the available line voltage is 220/240 Vac.

b. A power cable. Refer to Power Cables in Section II for HP Part Number.

### 1-17. EQUIPMENT AVAILABLE

1-18. Information may be obtained on the accessories and equipment, or they may be ordered by contacting your nearest Hewlett-Packard office. Refer to the HP model number.

### 1-19. Complementary Equipment

1-20. HP Model 204C/D Oscillators. Fully compatible for external modulation of the Signal Generator.

1-21. HP Model 8447C Amplifier. Suitable for increasing the output level of the 8654A. Typical gain is 30 dB.

1-22. HP Model 8447E Amplifier. Suitable for increasing the output level of the 8654A. Typical gain is 22 dB; much wider frequency range than the HP 8447C.

1-23. HP Model 5300A/5303A Electronic Counter. May be used to monitor the output frequency of the Signal Generator.

### 1-24. Accessories

1-25. HP Model 11509A Fuseholder. Protects the Signal Generator against accidental burnout of output circuits during transceiver testing. If the transceiver is accidentally switched to "transmit", the fuse is "burned out" and the generator output port is isolated from the high level RF energy. The fuseholder does not limit the usable output of the generator.

1-26. HP Model 11507A Output Termination. May be used to match the Signal Generator's 50-ohm output to high or low impedance circuits (5-ohms minimum) at frequencies to 65 MHz. Also, may be used as a dummy antenna for receiver measurements.

1-27. HP Model 11687A 50- to 75-ohm Adapter. May be used to match the 50-ohm Signal Generator output to a 75-ohm load. Calibrated output in volts.

1-28. HP Model 11690A Frequency Doubler. Extends the usable frequency range of signal sources to 1 GHz. Typical conversion loss is 12 dB.

1-29. HP Model 10514A Double Balanced Mixer. May be used as a current controlled attenuator; amplitude, pulse, or square wave modulator; or phase detector.

1-30. Transit Case. Protects the 8654A from damage while transporting it from location-to-location. Meets the requirements of MIL-C-4150. HP Part Number 9211-1895.

### 1-31. RECOMMENDED TEST EQUIPMENT

1-32. The equipment recommended for performance testing, adjustments and troubleshooting is listed in Table 1-2. Only equipment that meets or exceeds the critical specifications should be used in place of that shown in the table.

Table 1-1. Specifications (1 of 2)

**8654A SPECIFICATIONS**

Specifications apply from 10-520 MHz for output power  $\leq +10$  dBm and over the top 10 dB of output level vernier range unless otherwise specified.

**FREQUENCY CHARACTERISTICS**

**Range:** 10 to 520 MHz in 6 bands

10 — 18.6 MHz    35—66 MHz    130—250 MHz

18.6 — 35 MHz    66—130 MHz    250—520 MHz

**Accuracy:**  $\pm 2\%$  after 1-hour warmup.

**Settability:** Easily settable to within 1 ppm of the desired frequency with an external indicator.

**Stability:**

**Time:**  $< 40$  ppm/5-minutes (1 hour after turn-on and 15 minutes after frequency change).

**Line Voltage:**  $< 1$  ppm for  $+5\%$  to  $-10\%$  change from nominal line voltage.

**Level Change:**  $< 1$  ppm for a 10 dB output level change.

**Load:**  $< 1$  ppm with any passive load change for power settings  $< +3$  dBm.

**SPECTRAL PURITY**

**Harmonic Distortion:**  $> 20$  dB below carrier 10 — 520 MHz;  
 $> 25$  dB below carrier 18.6 — 130 MHz.

**Subharmonics and Non-harmonic Spurious:** (excluding line related) none measurable.

**Residual AM:** (averaged rms)  $> 70$  dB below carrier in a 0.3—3 kHz post-detection noise bandwidth;  $> 60$  dB

below carrier in a 50 Hz to 15 kHz post-detection noise bandwidth.

**Residual FM<sup>1</sup>:** (averaged rms deviation)  $< 0.5$  ppm in a 0.3—3 kHz post-detection noise bandwidth;  $< 1$  ppm in a 50 Hz to 15 kHz post-detection noise bandwidth.

**NOTE**

<sup>1</sup> Measured with noise level  $< 60$  dB relative to

$2 \times 10^{-4}$   $\mu$ bar (typical production test environment).

**OUTPUT CHARACTERISTICS**

**Range:** 10 dB steps and a 13 dB vernier provide power settings from  $+10$  dBm to  $-130$  dBm (0.7 V to 0.07  $\mu$ V) into 50 $\Omega$ .

**Level Accuracy:**

**Level Flatness:**  $\pm 1$  dB referenced to the output at 50 MHz for output levels  $> -7$  dBm.

**Impedance:** 50 $\Omega$  ac coupled, 75 Vdc maximum, VSWR  $< 1.3:1$  on 0.1 V range or lower.

Using Top 10 dB of Vernier Range					Using Full Vernier Range
Output Level (dBm)	+10 to -7	-7 to -57	-57 to -97	-97 to -127	+10 to -130
Total Accuracy as Indicated on Level Meter (dB)	$\pm 1.5$	$\pm 2.0$	$\pm 2.5$	$\pm 3.0$	Add $\pm 0.5$

Note: Level Accuracy error consists of allowances for: meter accuracy, detector linearity, temperature, flatness, attenuator accuracy, and twice the measurement error. All but the attenuator accuracy and the measurement error can be calibrated out with a power meter at a fixed frequency and a fixed vernier setting.

**Auxiliary RF Output:** nominally  $-7$  dBm (100 mV).

**Leakage:** (with all RF outputs terminated properly)  
Leakage limits are below those specified in

MIL-I-6181D. Furthermore, with an output level  $< 0.01$  V, less than 0.5  $\mu$ V is induced in a 2-turn, 1-inch diameter loop 1-inch away from any surface and measured into a 50 $\Omega$  receiver.

Table 1-1. Specifications (2 of 2)

**MODULATION CHARACTERISTICS**

**Amplitude Modulation<sup>2</sup>:** Specifications apply for output power  $< +3$  dBm.

**Depth:** 0 to 90%.

**Modulation Rate:** Internal, 400 & 1000 Hz  $\pm 10\%$ ;  
External 3 dB bandwidth, dc-coupled to  $> 20$  kHz.

**External AM Sensitivity:**  $(0.10 \pm 0.01)\%$  AM/mV<sub>pk</sub> into 600 $\Omega$  at 400 and 1000 Hz rates.

**Indicated AM Accuracy:**  $\pm(5\%$  of reading  $+5\%$  of full scale) for modulation rates of 400 and 1000 Hz.

**Peak Incidental Frequency Deviation:** (30% AM) less than 100 Hz plus 0.1 times modulation rate.

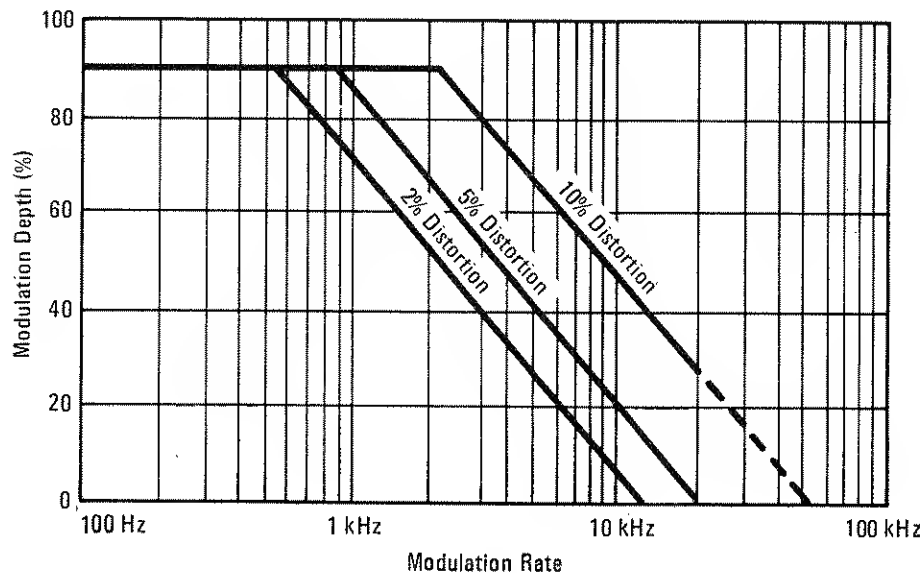
**Envelope Distortion:**

**Frequency Modulation:**

**Deviation:** at least 0.1% of carrier frequency.

**Modulation Rate:** Internal, 400 & 1000 Hz  $\pm 10\%$   
External 3 dB bandwidth, dc-coupled to  $> 25$  kHz driven from 600 ohms or less.

**External FM Sensitivity:** 10 V<sub>pk</sub> into 600 $\Omega$  yields  $> 0.1\%$  deviation ( $\pm 15$  volts max).

**NOTE**

<sup>2</sup> AM is possible above +3 dBm as long as the combination of the AM depth plus carrier output level does not exceed +9 dBm.

**GENERAL CHARACTERISTICS**

**Power:** 100, 120, 220 or 240 Volts  $+5\%$ ,  $-10\%$ , 48 to 440 Hz; 15 VA maximum. 7-1/2 Ft. (2,29 m) power cable furnished with mains plug to match destination requirements.

**Weight:** Net, 16 lbs 4 oz. (7,4 kg).

**Dimensions:** 10-1/2" W x 6-1/8" H x 11" D (266 mm x 155 mm x 279, 4 mm).

## SECTION II INSTALLATION

### 2-1. INTRODUCTION

2-2. This section provides information on incoming inspection, selecting the input line voltage, operating environment, and information applicable to bench and rack mounted operation of the Model 8654A.

### 2-3. INITIAL INSPECTION

2-4. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. The contents of the shipment are shown in Figure 1-1, and the procedures for checking electrical performance are given in Section IV. If the contents are incomplete, if there is mechanical damage or defects, or if the instrument does not pass the electrical performance test, notify the nearest Hewlett-Packard office. If the shipping container is damaged or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection. The HP office will arrange for repair or replacement without waiting for claim settlements.

### 2-5. PREPARATION FOR USE

#### 2-6. Meter Zeroing

2-7. With the power off, the meter's pointer should be positioned directly over zero. If the pointer is not on zero, insert a screwdriver into the adjustment screw, (beneath meter), and align the pointer with zero on the meter scale.

#### 2-8. Power Requirements

2-9. The 8654A Signal Generator requires a power source of 100, 120, 220 or 240 Vac  $\pm 5\%$   $-10\%$ , 48 to 440 Hz single phase. Power consumption is less than 30 VA.

#### 2-10. Line Voltage Selection

2-11. Figure 2-1 provides instructions for line voltage and fuse selection. The line voltage selec-

tion card and the proper fuse are factory installed for 120 Vac operation.

#### CAUTION

To prevent damage to the instrument make the line voltage selection before connecting the power cable.

#### NOTE

The correct fuse rating for the line voltage is shown beneath the window on the Power Module Assembly. More information about the fuses is given in Section I, ACCESSORIES SUPPLIED and in the Replaceable Parts table in Section VI.

### 2-12. Power Cable

2-13. In accordance with international safety standards, this instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument cabinet. The type of power cable plug shipped with each instrument depends on the country of destination. Refer to Figure 2-2 for the part numbers of the power cable plugs available.

#### WARNING

The protection provided by grounding the instrument cabinet may be lost if any power cable other than the three-pronged type supplied is used to couple the ac line voltage to the instrument.

### 2-14. Operating Environment

2-15. The operating environment should be within the following limitations:

Temperature . . . . .	0 to 55°C
Humidity . . . . .	< 95% relative
Altitude . . . . .	< 15,000 feet

### 2-16. Bench Operation

2-17. The instrument cabinet has plastic feet and foldaway tilt stands for convenience in bench

operation. The plastic feet are shaped to ensure self-aligning of the instruments when stacked (handle must be removed). The tilt stands raise the front of the instrument for easier viewing of the control panel.

## 2-18. Rack Mounting

**2-19. Rack Adapter Frames.** Hewlett-Packard adapter frames are an economical means of rack mounting instruments that are narrower than full rack width. A set of spacer clamps, supplied with each adapter frame, permits instruments of different dimensions to be combined and rack mounted as a unit. Accessory blanks are available for filling unused spaces.

**2-20. Combining Cases.** Model 1051A and 1052A Combining Cases are metal enclosures that allow combinations of third- or half-rackwidth instruments to be assembled for use on a workbench or for mounting in a rack of standard 19-inch spacing. Each case includes a set of partitions for positioning and retaining instruments, and a rack mounting kit. No tools are required for installing the partitions. For bench use the cases have the same convenience features as full rackwidth instruments (i.e., foldaway tilt stands and specially-designed feet for easier instrument stacking). Accessories available for the combining cases include fan kits, blank filler panels, and snap-on full width control panel covers.

## 2-21. STORAGE AND SHIPMENT

### 2-22. Environment

2-23. The instrument should be stored in a clean-dry environment. The following environmental limitations apply to both storage and shipment:

Temperature . . . . . -40 to +75°C  
Humidity . . . . . < 95% relative  
Altitude . . . . . < 25,000 feet

### 2-24. Packaging

**2-25. Original Packaging.** Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also, mark the container FRAGILE to assure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

**2-26. Other Packaging.** The following general instructions should be used for re-packaging with commercially available materials:

a. Wrap the instrument in heavy paper or plastic. (If shipping to a Hewlett-Packard office or service center, attach a tag indicating the type of service required, return address, model number, and full serial number.)

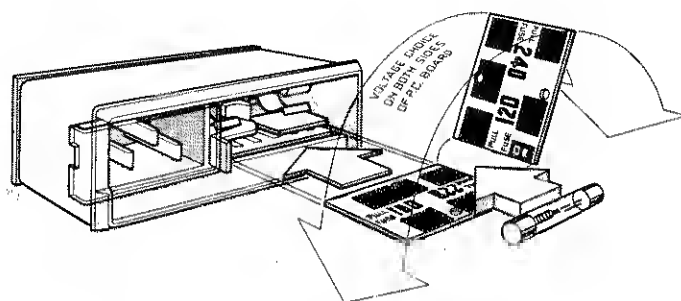
b. Use a strong shipping container. A double-wall carton made of 350-pound test material is adequate.

c. Use enough shock-absorbing material (3- to 4-inch layer) around all sides of the instrument to provide a firm cushion and prevent movement inside the container. Protect the control panel with cardboard.

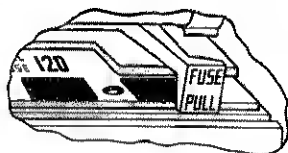
d. Seal the shipping container securely.

e. Mark the shipping container FRAGILE to assure careful handling.





Operating voltage is shown in module window.



#### SELECTION OF OPERATING VOLTAGE

1. Open cover door, pull the FUSE PULL lever and rotate to left. Remove the fuse.
2. Remove the Line Voltage Selection Card. Position the card so the line voltage appears at top-left corner. Push the card firmly into the slot.
3. Rotate the FUSE PULL lever to its normal position. Insert a fuse of the correct value in the holder. Close the cover door.

Figure 2-1. Line Voltage Selection

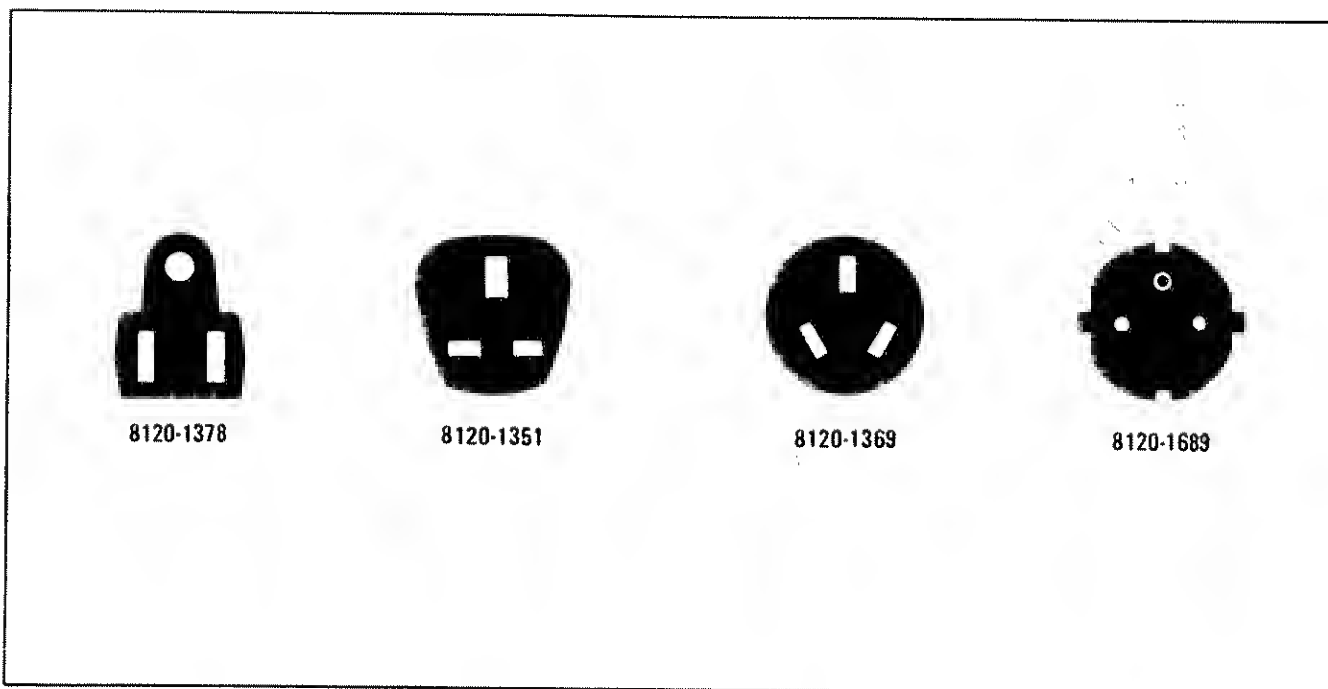
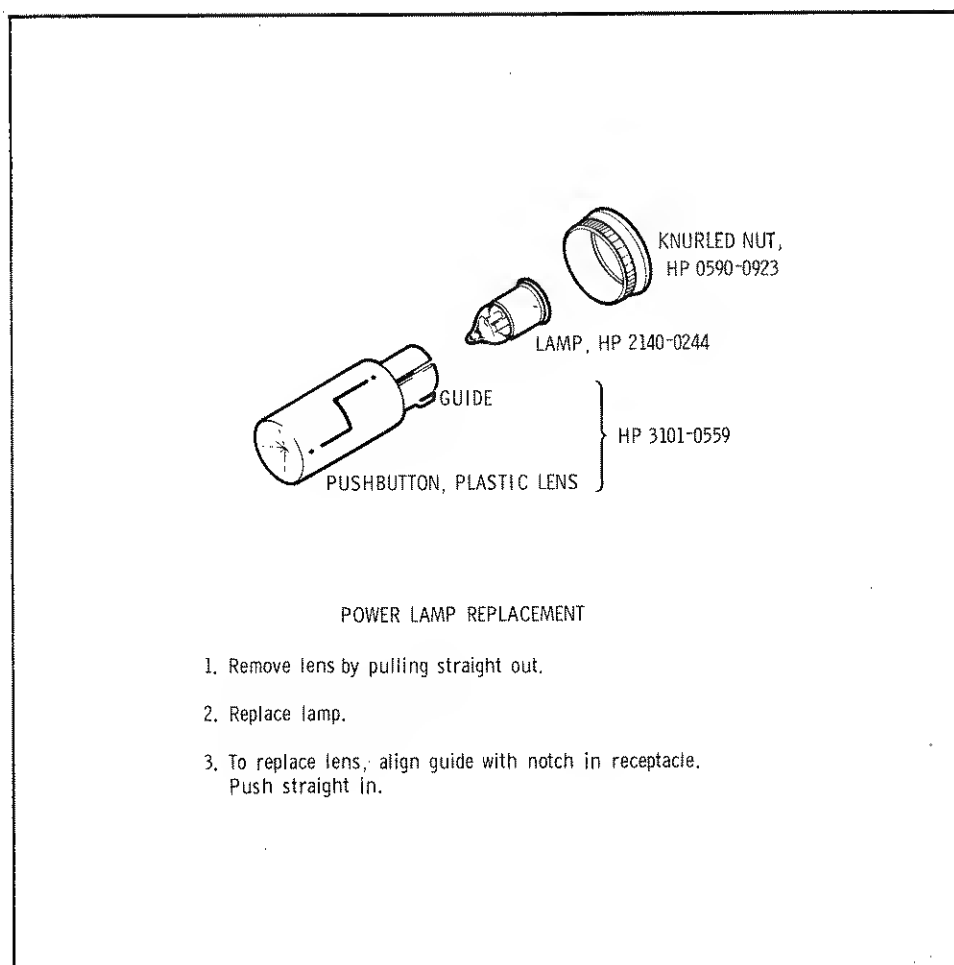


Figure 2-2. Power Cable HP Part Numbers versus Mains Plugs Available



*Figure 3-1. Power Lamp Replacement*

## SECTION III OPERATION

### 3-1. INTRODUCTION

3-2. This section provides complete operating instructions for the HP 8654A Signal Generator. The instructions consist of: panel features, operator's checks, operating instructions, and operator's maintenance.

### 3-3. PANEL FEATURES

3-4. Front and rear panel features of the 8654A Signal Generator are described in Figures 3-2 and 3-3. These figures contain a detailed description of the Signal Generator controls, indicators, and connectors.

### 3-5. OPERATOR'S CHECKS

3-6. Upon receipt of the instrument, or to check the Signal Generator for an indication of normal operation, perform the operational procedures listed in Figure 3-4. These procedures are designed to familiarize the operator with the Signal Generator and permit a determination of operating capabilities.

### 3-7. OPERATING INSTRUCTIONS

3-8. General operating instructions are contained in Figure 3-5. The instructions will familiarize the operator with basic operating functions of the Signal Generator.

### 3-9. Calculating External FM Drive Voltage

3-10. The external FM drive voltage needed to obtain a desired peak frequency deviation of the carrier may be calculated from the relationship between the peak frequency deviation and FM sensitivity. See Figure 3-6.

3-11. The curve shown in Figure 3-7 relates FM sensitivity to carrier frequency for each band.

### 3-12. Pulse Modulation

3-13. Pulse modulation of the 8654A is possible by using a pulse generator coupled to the signal generator through the external AM INPUT jack. Figure 3-8 explains in detail how to accomplish pulse modulation.

### 3-14. Auxiliary Output

3-15. The isolation of the AUX OUTPUT from the front panel RF OUTPUT is typically 30 dB. Any signal that is coupled into the AUX OUTPUT may be transmitted to the generator's output. An example of this is an electronic counter used to monitor the RF output frequency. Subharmonic signals at the counter input are coupled into the AUX OUTPUT and from there to the front panel output where they are transmitted to the load.

### 3-16. OPERATOR'S MAINTENANCE

3-17. The maintenance responsibilities of the operator are replacing the primary fuse and LINE switch lamp.

3-18. **Fuses.** The fuse is located on the rear panel within the power module assembly. Figure 2-1, steps 1 and 3, explain how to remove and install the fuse. The fuses may be ordered under HP Part Numbers 2110-0004, 1/4 A (for 100/120 Vac operation; 2110-0027, 1/8 A (for 220/240 Vac operation).

3-19. **Line Switch Lamp Replacement.** The lamp is contained in the white plastic lens which doubles for the pushbutton on the LINE switch. When the instrument is ON the lamp should be illuminated.

3-20. Figure 3-1 shows the method of removing and installing the lamp. A replacement lamp, DS1, may be ordered under HP Part Number 2140-0244.

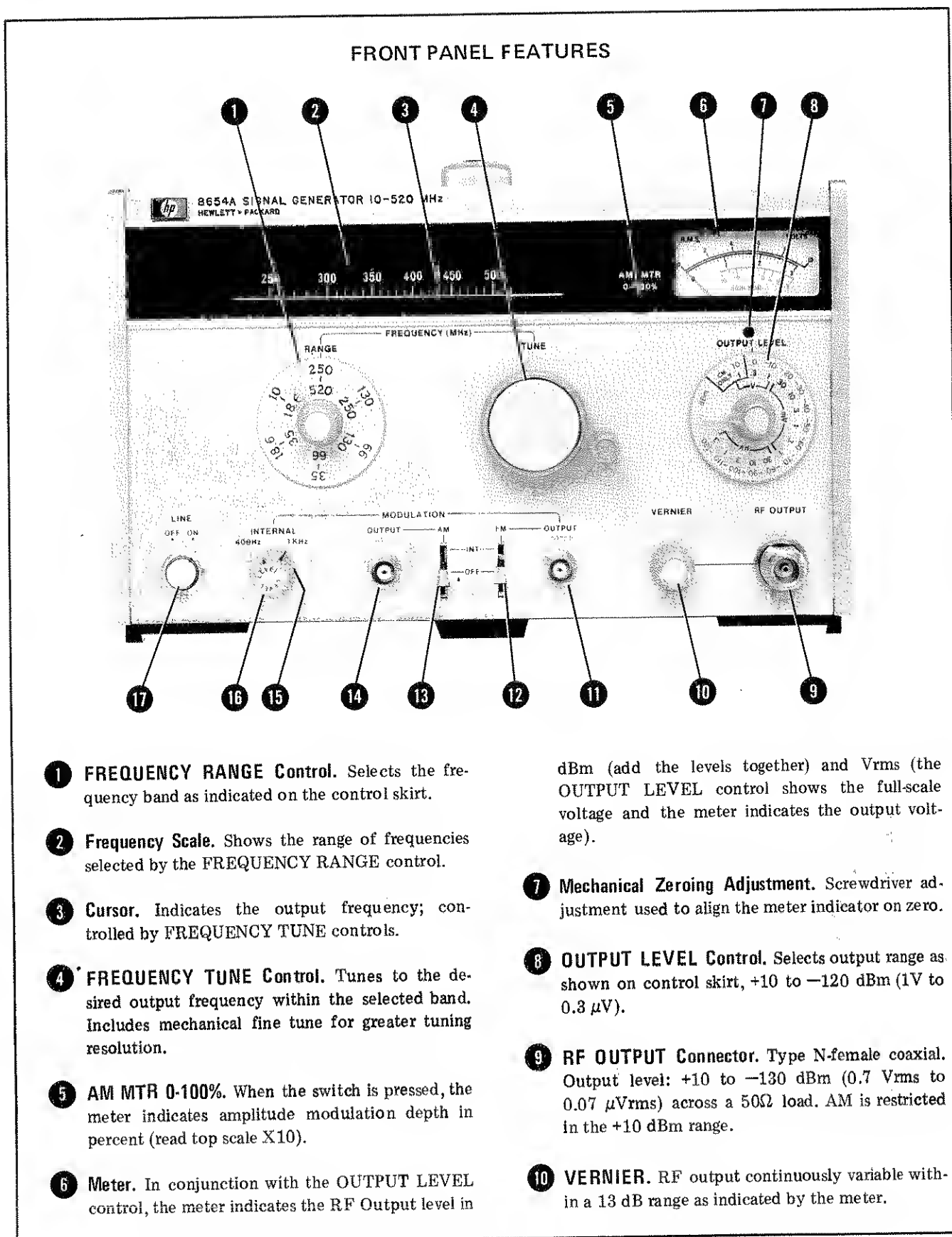


Figure 3-2. Front Panel Controls, Connectors, and Indicators (1 of 2)

## FRONT PANEL FEATURES

- 11 FM OUTPUT/INPUT Jack.** Open circuit output present during internal modulation is  $\approx 5$  Vrms, (output impedance is approximately  $10\text{ k}\Omega$ ). For external FM an audio tone must be coupled to the jack, (input impedance is approximately  $600\Omega$ ).

**CAUTION**

Voltage levels more positive than +15V or more negative than -20V may damage 8654A internal circuitry if coupled to the FM INPUT jack.

- 12 FM MODULATION Switch.** Selects internal (INT) or external (EXT) frequency modulation, or OFF.
- 13 AM MODULATION Switch.** Selects internal (INT) or external (EXT) amplitude modulation, or OFF.

**NOTE**

A mechanical interlock prevents simultaneous internal amplitude and frequency modulation.

- 14 AM OUTPUT/INPUT Jack.** Open circuit output present during internal modulation is  $\approx 5$  Vrms (output impedance  $\approx 10\text{ k}\Omega$ ). For external AM an audio tone must be coupled to the jack (input impedance  $\approx 600\Omega$ ).

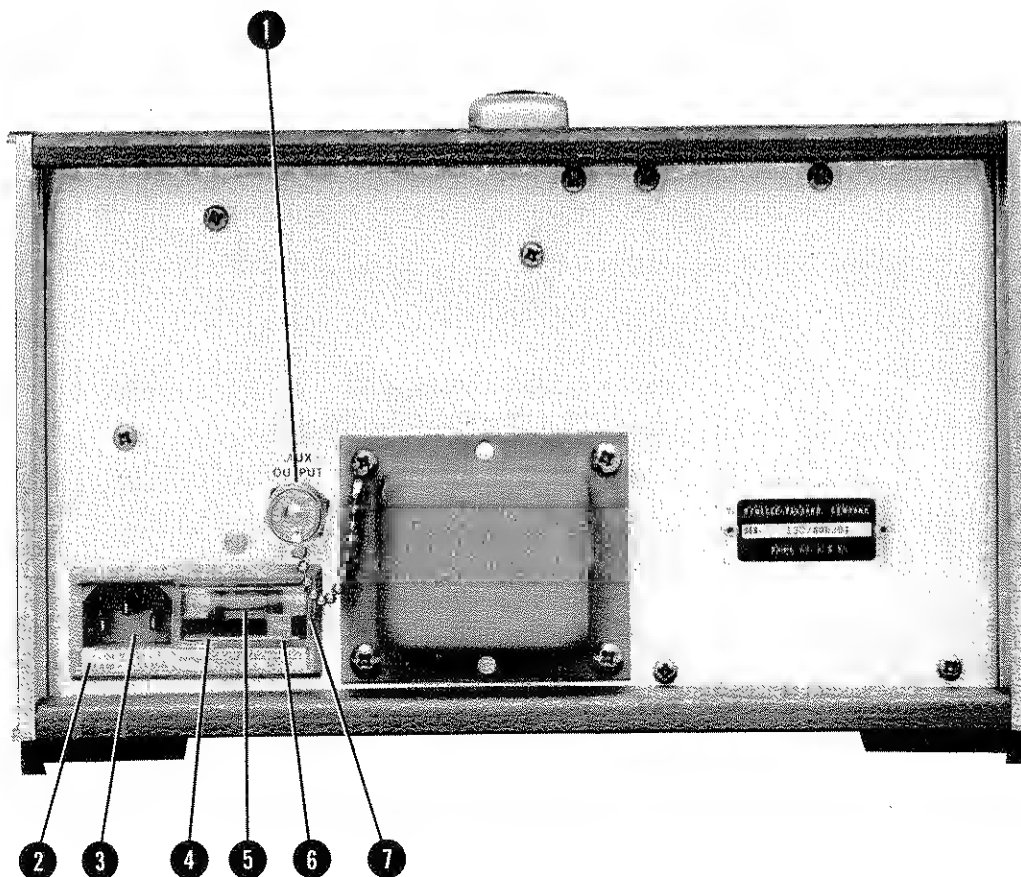
**CAUTION**

Voltage levels more positive than +8V or more negative than -8V may damage internal circuitry of the 8654A when coupled to the AM INPUT jack.

- 15 INTERNAL MODULATION Frequency Switch.** Selects 400 or 1000 Hz internal modulation signal rate.
- 16 LEVEL Control.** Sets AM depth or FM deviation in the internal modulation mode.
- 17 LINE Switch.** Controls primary power. Illuminated when the instrument is ON.

Figure 3-2. Front Panel Controls, Connectors, and Indicators (2 of 2)

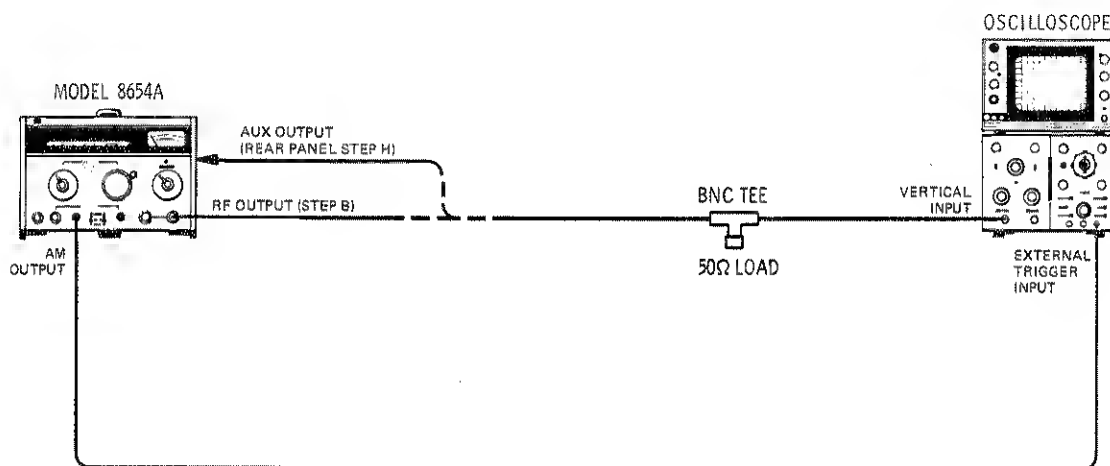
## REAR PANEL FEATURES



- 1 **AUX OUTPUT Connector.** Output is RF signal, 10 to 520 MHz at  $\geq -7$  dBm (fixed level) into a  $50\Omega$  load.
- 2 **Power Module Assembly.**
- 3 **Receptacle.** For Power Cable coupling to available line voltage.
- 4 **Line Voltage Selection Card.** Matches transformer primary to available line voltage.
- 5 **Fuse.** 1/4 Amp for 100/120 Vac; 1/8 Amp for 220/240 Vac.
- 6 **FUSE PULL Handle.** Mechanical interlock to guarantee fuse has been removed before Line Voltage Selection Card can be removed.
- 7 **Window.** Safety interlock; fuse cannot be removed while power cable is coupled to the 8654A.

Figure 3-3. Rear Panel Controls, Connectors and Indicators

## OPERATOR'S CHECKS



- Verify that the power transformer primary is matched to the line voltage and that the correct fuse is installed within the rear panel Power Module Assembly. See Line Voltage Selection in Section II.
- Couple the power cable to the power outlet and Power Module receptacles. When the LINE switch is set to ON, the lamp within the switch lens should be illuminated.
- Set the 8654A controls as follows:

FREQUENCY RANGE	10 - 18.6 MHz
FREQUENCY TUNE	10.0 MHz
OUTPUT LEVEL	0.1 Vrms
VERNIER	full scale meter reading, (0.1 Vrms)
AM MODULATION	OFF
FM MODULATION	OFF
INTERNAL MODULATION	1000 Hz

- Connect the equipment as shown above and verify that the 10.0 MHz signal has an output level of  $\approx 0.3$  Vp-p.

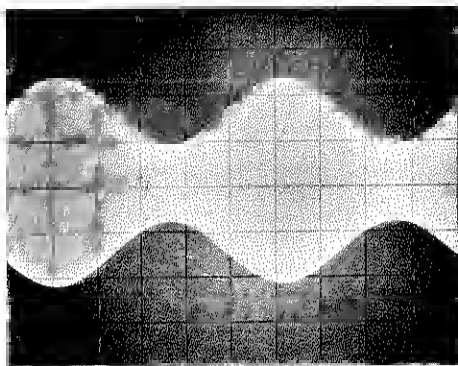
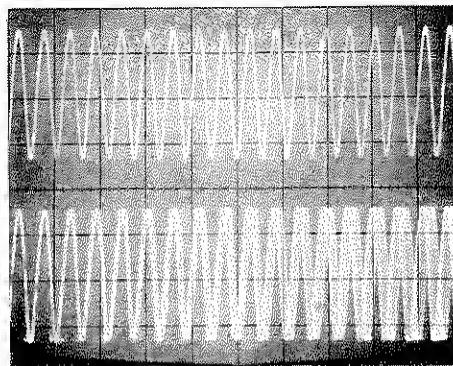
## NOTE

The oscilloscope must have a bandwidth of  $\geq 10$  MHz to perform these checks.

- Set the 8654A AM MODULATION switch to INT; set the oscilloscope time base trigger to external.
- Press the AM MTR switch and rotate the LEVEL control cw until the meter indicates 50% modulation depth (5). Verify that the AM envelope display shows a peak-to-valley voltage difference of about 0.15 V with a period of 1.0 ms.

Figure 3-4. Operator's Checks (1 of 2)

## OPERATOR'S CHECKS

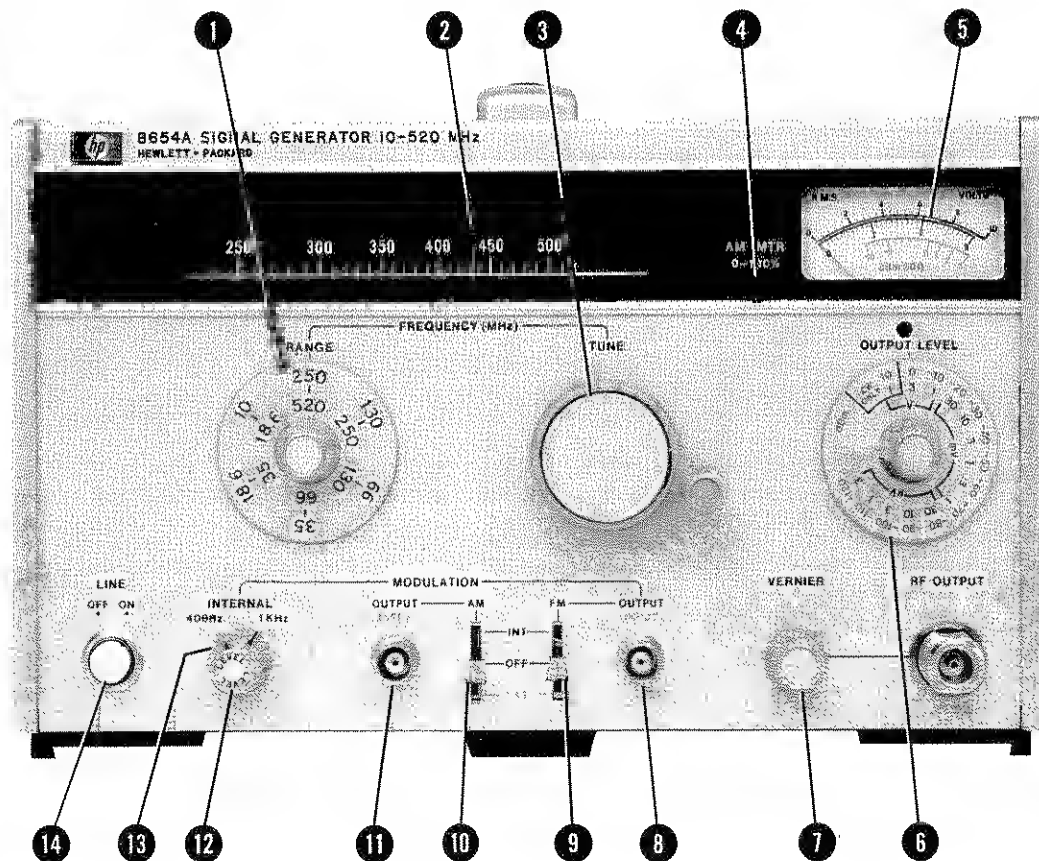
*Typical AM Envelope**Typical FM Display with  
CW Display for Comparison*

- g. Set the INTERNAL MODULATION switch to 400 Hz; verify the AM envelope period is 2.5 ms.
- h. Set the AM MODULATION switch to OFF and set the FM MODULATION switch to INT. Set the Oscilloscope time base trigger to internal.
- i. Rotate the LEVEL control cw. Verify that the oscilloscope shows the typical FM display. (Increasing the RF output frequency will increase the FM deviation shown by the oscilloscope.)
- j. Connect the 8654A AUX OUTPUT to the oscilloscope vertical input and verify that a 10.0 MHz signal of  $\geq 0.3$  Vp-p is displayed.

*Figure 3-4. Operator's Checks (2 of 2)*



## OPERATING INSTRUCTIONS



## TURN ON

- Verify that the power transformer primary is matched to the line voltage. See Line Voltage Selection in Section II.
- Check the fuse, which is contained in the Power Module Assembly, for the correct rating. The voltage and amperage are given in a table on the Power Module Assembly below the window. If necessary, change the fuse.
- Couple the power cable to the power outlet and Power Module receptacles. Press the LINE switch 14 and release. The switch should remain in, the lamp within the plastic lens should be illuminated, and the cursor on the curved portion of the switch should indicate ON.

## NOTE

To ensure the 8654A will perform to the standards set forth in the published specifications, let the instrument warm up for one hour before using.

Figure 3-5. Operating Instructions (1 of 3)

**OPERATING INSTRUCTIONS****FREQUENCY SELECTION**

- d. Set the FREQUENCY RANGE control ① to the band which includes the desired carrier frequency.
- e. Tune to the carrier frequency with the FREQUENCY TUNE control ③; the mechanical fine tune provides greater tuning resolution. The Cursor ② indicates the carrier frequency.

**OUTPUT LEVEL SELECTION**

- f. Set the OUTPUT LEVEL range control ⑥ and VERNIER ⑦ to the desired output level. For optimum AM performance and level meter accuracy, the VERNIER control should be set for a meter indication of  $-7$  to  $+3$  dBm ( $> 1/3$  full scale). Amplitude modulation is restricted in the  $+10$  dBm range.
- g. Vary the VERNIER control ⑦ until the level shown on the OUTPUT LEVEL range control ⑥ added to the meter indication ⑤ equal the desired level. (For voltage keep in mind that meter indication of  $-7$  to  $+3$  dBm ( $> 1/3$  full scale). Amplitude modulation is restricted in the  $+10$  dBm range.

**AM MODULATION - INTERNAL**

- h. Set AM MODULATION switch ⑩ to INT.
- i. Select 400 or 1000 Hz modulation rate with the INTERNAL MODULATION frequency switch ⑬.
- j. Press the AM MTR switch ④ and vary the LEVEL control ⑫ until the meter ⑤ indicates the desired modulation depth. Use top scale ( $10 = 100\%$ ).

**AM MODULATION - EXTERNAL**

- k. Set the AM MODULATION switch ⑩ to EXT.
- l. Set the external generator output to a minimum; connect the output to the AM INPUT jack ⑪.

**NOTES**

1. The input impedance of the AM INPUT is  $\approx 600$  ohms.
  2. Voltage levels more positive than  $+2$  Vdc or more negative than  $-2$  Vdc at the AM INPUT jack should be avoided.
- m. Set the external signal modulating rate (20 kHz maximum).

*Figure 3-5. Operating Instructions (2 of 3)*

## OPERATING INSTRUCTIONS

- n. Press the AM MTR switch ④ and increase the external generator output until the meter ⑤ indicates the desired modulation depth.

## NOTES

1. Amplitude modulation is not recommended when the OUTPUT LEVEL control is set to +10 dBm. If AM is necessary, monitor the RF output with an oscilloscope; verify that the distortion is minimal. Frequency modulation is permissible.
2. The modulation meter responds to the positive peak of the modulation signal. If the modulation signal waveform is asymmetrical or if it has a dc component, the meter reading will be in error.

## FM MODULATION - INTERNAL

- o. Set the FM MODULATION switch ⑨ to INT.
- p. Select 400 or 1000 Hz internal modulating rate with the INTERNAL MODULATION frequency switch ⑬.
- q. The FM peak deviation is set by the LEVEL control ⑫.

## FM MODULATION - EXTERNAL

- r. Set the FM MODULATION switch ⑨ to EXT.
- s. Set the external generator output level to a minimum. Connect the generator to the FM INPUT jack ⑧.

## CAUTION

Damage to the 8654A internal circuitry may occur if inputs more positive than +15V or more negative than -20V are coupled to the FM INPUT jack.

## NOTE

The FM INPUT impedance is  $\approx 600$  ohms.

- t. Set the external modulating rate (25 kHz maximum).
- u. Figure 3-5 shows how to find the input from the test generator that will produce the desired peak deviation of the carrier frequency. The FM drive voltage is measured at the FM INPUT jack.

## SIMULTANEOUS AM AND FM MODULATION

- v. If the desired AM frequency is 400 or 1000 Hz, follow the instructions given for AM MODULATION-INTERNAL and FM MODULATION-EXTERNAL. Otherwise follow the procedures, AM MODULATION-EXTERNAL and FM MODULATION-EXTERNAL.

Figure 3-5. Operating Instructions (3 of 3)

### CALCULATING FM DRIVE VOLTAGE

The following procedure explains the method for calculating FM drive voltage,  $V_d$ .

$$V_d = \frac{\text{Desired Peak Deviation (kHz-pk)}}{\text{FM Sensitivity (peak deviation, kHz - pk/Vpk)}}$$

- From Figure 3-7, find the FM sensitivity for the carrier frequency desired. Enter the value in the formula.
  - Enter the desired peak frequency deviation.
  - Calculate the FM drive voltage,  $V_d$ .
- Example:

Desired carrier frequency . . . . . 102.1 MHz  
Desired peak frequency deviation . 100 kHz - pk (200 kHz bandwidth)

From Figure 3-7, the FM sensitivity for 102.1 MHz is 60 kHz - pk/Vpk.

$$V_d = \frac{100}{60} V_{pk}$$

$$V_d = 1.67 V_{pk}$$

#### CAUTION

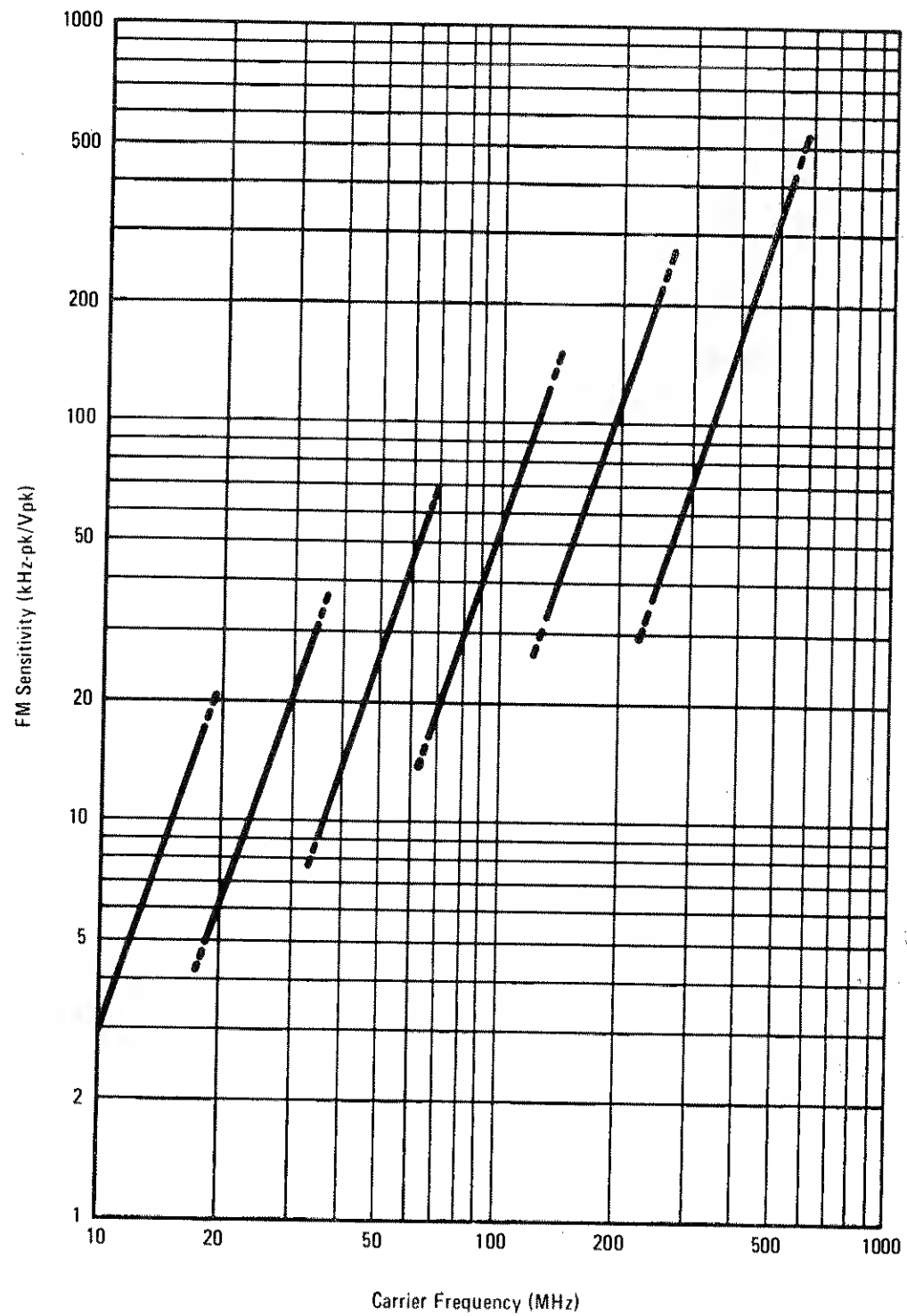
Input voltages more positive than +15V or more negative than -20V may damage 8654A internal circuitry.

#### NOTES

- The FM sensitivity accuracy is typically  $\pm 25\%$ , therefore, the 1.67 Vpk drive signal will normally produce a peak carrier deviation between 75 - 125 kHz.
- The detected FM signal distortion is dependent on FM drive voltage and may be determined by the following equation.

$$\text{FM Distortion} = (2 V_d) \% \text{ for } V_d \leq 10 V_{pk}$$

Figure 3-6. Calculating FM Drive Voltage

*Figure 3-7. FM Sensitivity*

### PULSE MODULATION

Pulse Modulating the 8654A may be accomplished in the following manner:

- a. Set the 8654A FREQUENCY RANGE and TUNE controls to the desired frequency; the AM and FM MODULATION controls to OFF.
- b. Set the 8654A OUTPUT LEVEL and VERNIER controls to the desired output level. (This will be the output level during pulse on-time.)
- c. Connect the Pulse Generator to the AM INPUT jack.
- d. Set the Pulse Generator controls to produce a pulse on-time voltage of 0.0 Vdc and an off-time voltage of -1.5 Vdc. Set other pertinent Pulse Generator controls.

#### CAUTION

Voltages applied to the AM INPUT jack which are more positive than +8 Vdc or more negative than -8 Vdc may damage internal circuitry of the 8654A.



#### NOTES

1. The pulse on-time voltage must be 0.0 Vdc or the output level during the on-time will not be equal to the preset level.
2. The On-Off ratio is typically > 40 dB.

- e. Set the 8654A AM MODULATION control to EXT.

#### NOTE

The minimum rise time for pulse modulated output is typically 12  $\mu$ s.

Figure 3-8. Pulse Modulation